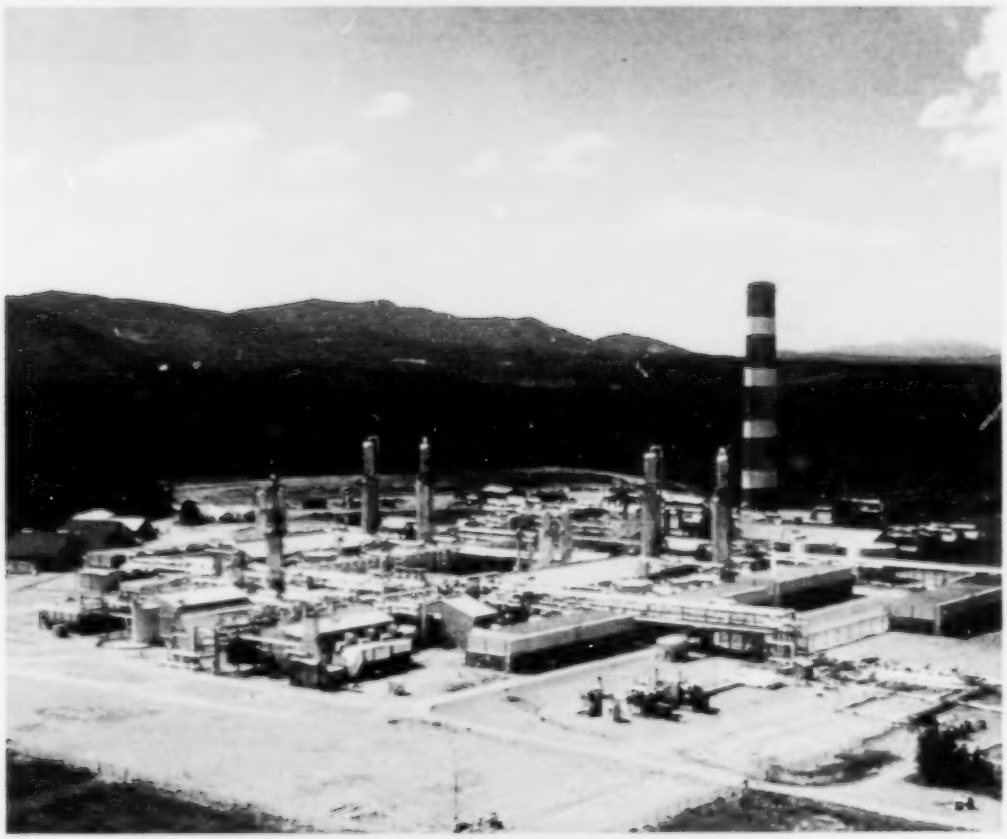
ST101-2005

EUB

Sulphur Recovery and Sulphur Emissions at Alberta Sour Gas Plants

Annual Report

August 2005



Alberta Energy and Utilities Board

ALBERTA ENERGY AND UTILITIES BOARD
ST101-2005: Sulphur Recovery and Sulphur Emissions at Alberta Sour Gas Plants

August 2005

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1 Introduction

In *Interim Directive (ID) 2001-3: Sulphur Recovery Guidelines for the Province of Alberta*, the Alberta Energy and Utilities Board (EUB) committed to monitoring the sulphur recovery of grandfathered[1] sour gas plants and publishing an annual summary report on industry performance. This report covers both grandfathered sour gas plants (sulphur recovery and larger acid gas flaring sour gas plants) and nongrandfathered[2] gas plants (sulphur recovery and all acid gas injection sour gas plants). A complete list of the grandfathered and nongrandfathered plants is in Appendices 1.1-1.4.

While *ID 2001-3* did not change the recovery levels expected for new gas plants, it set out clear expectations on when older grandfathered plants are required to meet the same requirements as new plants. The ID incorporates a phased approach to the more stringent requirements and encourages operators of sulphur recovery plants to take early action to improve performance.

Grandfathered sulphur recovery plants that perform better than the minimum requirements specified in *ID 2001-3* have the option to file sulphur emission performance credit report forms and may use the credits to meet a portion of the sulphur recovery requirements at a future date (i.e., operate for a longer time or at a higher inlet rate before having to degrandfather the plant). All grandfathered sulphur recovery plants are now taking advantage of the emission credit program, and credits are continuing to grow every year, as would be expected in these early years when credits are easier to earn.

Acid gas flaring plants have no ability to earn credits and are subject to more stringent requirements over time.

In the last five years a number of plants have degrandfathered:[3] 11 plants have made upgrades to their plant, 4 plants have been relicensed to meet the requirements for new plants, and 4 plants have ceased operating. There are 41 grandfathered plants remaining. In addition, sulphur emissions have decreased substantially for both grandfathered acid gas flaring plants (emissions down 39 per cent) and grandfathered sulphur recovery plants (emissions down 28 per cent).

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[1] Grandfathered plants are those that do not meet the sulphur recovery requirements for new plants listed in *ID 2001-3*. This includes some sulphur recovery plants and larger (sulphur inlet greater than 1 tonne per day [t/d]) acid gas flaring plants.

[2] Nongrandfathered plants are those with an approved sulphur inlet greater than 1 t/d meeting the requirements for new plants, as listed in *ID 2001-3*. This includes some sulphur recovery plants and all acid gas injection plants.

[3] Degrandfathered plants are those that did not previously meet the requirements of *ID 2001-3* for new plants but have now been relicensed to meet the requirements for new plants, as set out in the ID.

2 Summary of Performance for Grandfathered Plants, 2000-2004

2.1 Grandfathered Plants That Have Been Degrandfathered

In the last five years, 11 plants have made modifications to improve or install sulphur recovery at their plants to meet the more stringent sulphur recovery requirements for new plants. In addition, 4 other plants have been relicensed to meet these more stringent sulphur recovery requirements, and 4 grandfathered plants have shut down.

Plants making modifications to meet the requirements for new plants

Plant name	Operator
1. Brazeau River	Keyera
2. Garrington (Olds)	Esprit
3. Homeglen (Rimbey)	Keyera
4. Bantry	AltaGas
5. Vulcan (Long Coulee)	Conoco Phillips
6. Wilson Creek	Petro-Canada
7. Rainbow	Husky
8. Edson	Talisman (2004 modifications)
9. Retlaw (Turin)	Taylor Management (2004 modifications)
10. Virginia Hills	Apache (2004 modifications)
11. Bellshill	Viking (2005 modifications)

The 11 operators listed above made significant physical modifications to their plants to achieve higher sulphur recoveries.

Plants relicensing to meet the requirements for new plants

Plant name	Operator
1. Okotoks (Mazeppa)	Mazeppa Processing
2. Crossfield East	PrimeWest
3. Sylvan Lake	NAL Resources
4. Sturgeon Lake	Chariot Energy (2005)

Of the 4 plants listed above, 3 were relicensed to a higher sulphur recovery efficiency with existing equipment and/or minor modifications and 1 was relicensed to a lower throughput without modifications.

Grandfathered plants that have ceased operating

Plant name	Operator
1. North Rosevear	Suncor
2. Bittern Lake	CNRL
3. North Caroline	BP Canada
4. South Caroline	BP Canada

A detailed list of plants that have been degrandfathered in the last five years is in Appendix 2, along with the process used for improving the sulphur recovery.

As of June 2005, there are 21 grandfathered sulphur recovery plants and 20 grandfathered acid gas flaring plants remaining (see Appendix 1).

2.2 Sulphur Emission Performance Credits (Emission Credits)

Emission credits can be earned by grandfathered sour gas plants with sulphur recovery that achieve recovery efficiencies higher than their required blended sulphur recovery efficiency. Credits cannot be transferred between facilities and do not apply to acid gas flaring plants.

Credit reports can help an operator

- operate at higher sulphur inlets,
- meet the required blended sulphur recovery efficiency, and
- defer upgrading for a longer period of time.

In order to earn credits, a credit report must be filed on time at the end of each quarter. The filing of credit reports is optional, but once an initial credit report is filed, the operator must continue to file them. Reports may not be filed retroactively.

Each sulphur emission credit represents 1 tonne (t) of sulphur emissions that would have been emitted if the plant exactly met its minimum requirement. Credits must be earned before they can be used.

Most plants that are able to file credit reports are doing so, and the emission credits are growing, as one would expect in this initial period. As of the end of the fourth quarter of 2004, over 47 000 t of sulphur emission credits had been earned (see Figure 1). The total sulphur emissions from grandfathered sulphur recovery plants in 2004 was only 41 000 t. Emission credits as of December 2004 equate to about 12 months of emissions from the grandfathered sulphur recovery plants.

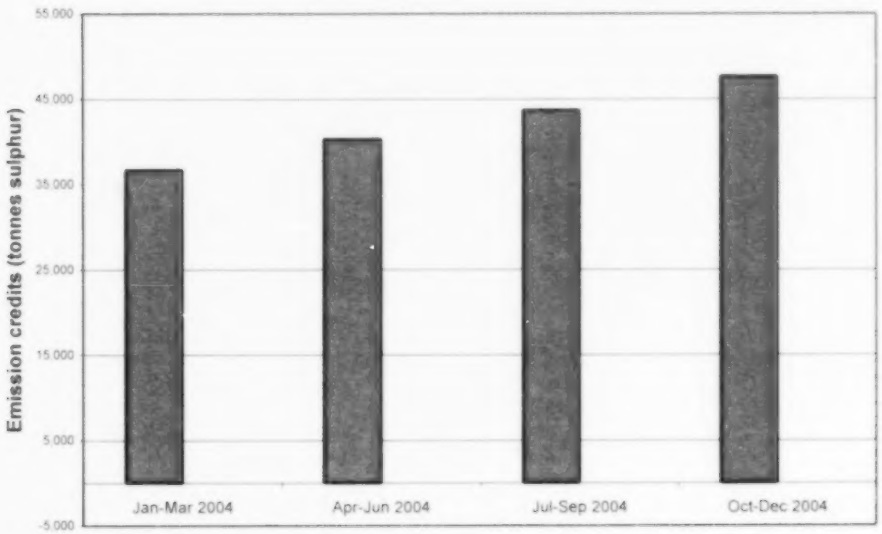

Figure 1. Net sulphur emission credits over time

Appendix 3 lists cumulative credits for each of the grandfathered sulphur recovery plants in 2004.

2.3 Sulphur Emissions and Inlets at Grandfathered Plants, 2000-2004

An analysis of the sulphur emissions and sulphur inlet for the specific plants that were listed in *ID 2001-3* as grandfathered follows in Sections 2.3.1 and 2.3.2. For the purpose of this analysis, plants that have degrandfathered since the ID was issued are included with the grandfathered plants.

2.3.1 Sulphur Emission Reduction

There have been substantial reductions in sulphur emissions from the grandfathered plants between 2000 and 2004, as shown in Figure 2.

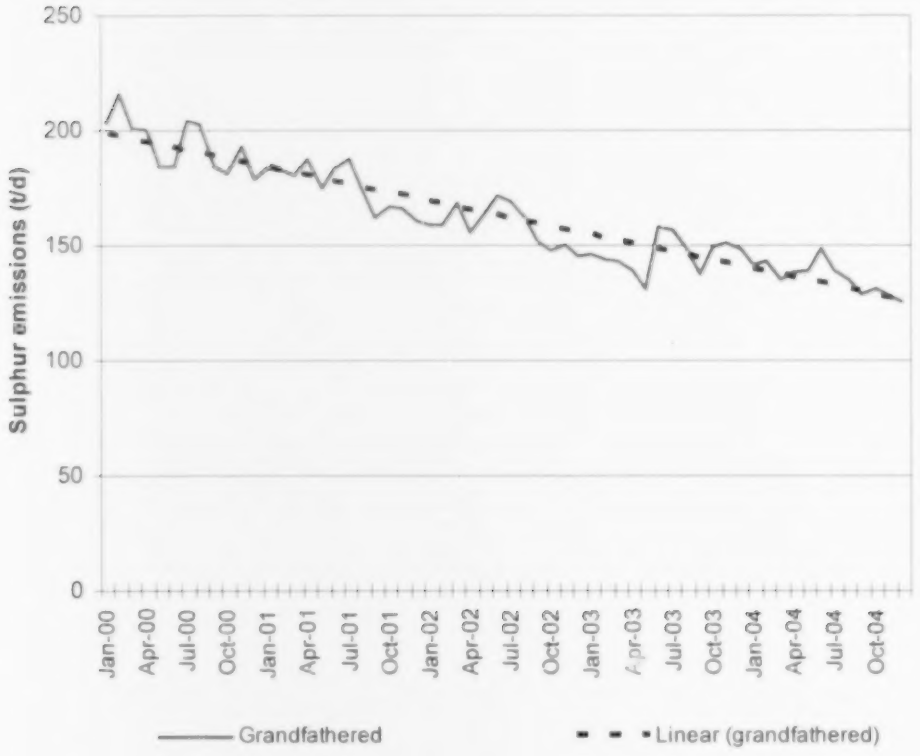

Figure 2. Sulphur emissions from grandfathered plants

The drop in emissions from grandfathered plants shown in Figure 2 is due to a decrease of about 39 per cent in emissions from the grandfathered acid gas flaring plants and a decrease of about 28 per cent from the grandfathered sulphur recovery plants between 2000 and 2004.

Of the 39 per cent decrease in emissions from grandfathered acid gas flaring plants from 2000 to 2004, about half, or 21 per cent, is due to declining sulphur inlet. The other 18 per cent is due in large part to the acid gas injection facility installed at ConocoPhillips Vulcan, the installation of sulphur recovery at PetroCanada Wilson Creek, and last year's installation of acid gas injection at Taylor Retlaw and Apache Virginia Hills. The Viking Energy Bellshill gas plant also became an acid gas injection facility in early 2005.

Between 2000 and 2004, 27 of the 28 grandfathered acid gas flaring plants showed emission reductions.

Of the 28 per cent decrease in emissions from grandfathered sulphur recovery facilities from 2000 to 2004, about 20 per cent is due to declining sulphur inlet. The other 8 per cent decrease in emissions is due in large part to improved operations at BP Windfall, Husky Ram River, and Shell Jumping Pound and the installation of acid gas injection at Keyera Brazeau. Between 2000 and 2004, 23 of the 28 grandfathered sulphur recovery plants reduced emissions, as shown in Appendix 4.

Appendix 4 lists sulphur production and emissions for each of the sulphur recovery plants for the years 2000 and 2004.

2.3.2 Decline in Sulphur Inlet

While improvements in operation and plant modifications have played a significant role in emission reductions at the grandfathered plants, as noted in the previous section, the reduction is also due to the declining sulphur inlets of these plants.

Figure 3 shows the decline in sulphur inlets for grandfathered gas plants.

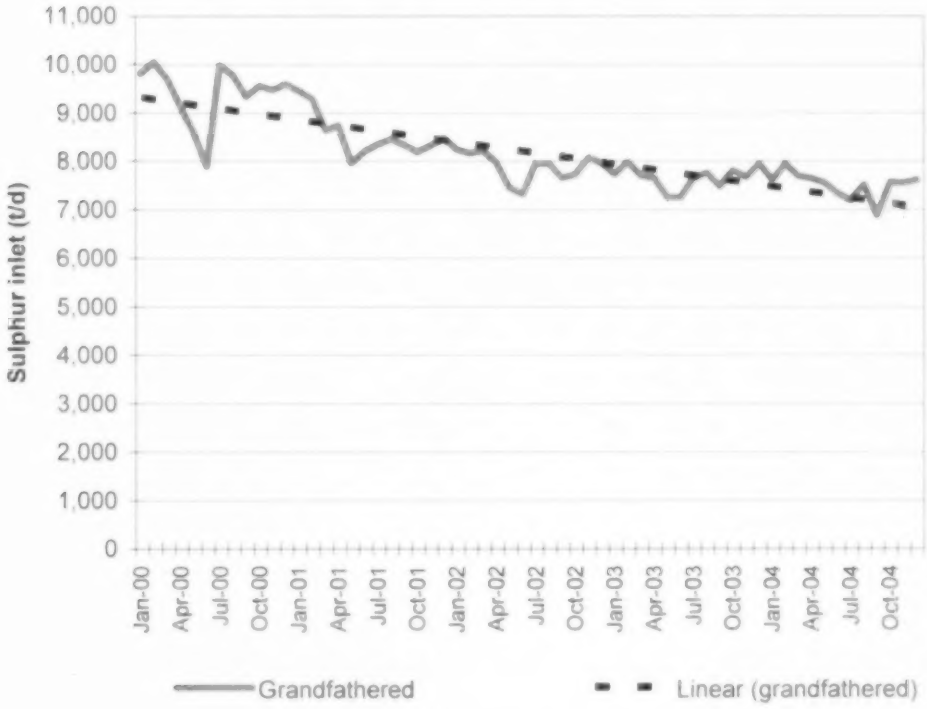

Figure 3. Sulphur inlet for grandfathered plants

3 Summary of Performance for Nongrandfathered Plants, 2000-2004

The sulphur emissions and sulphur inlet for the specific sour gas plants (having a sulphur inlet greater than 1 t/d) that met the requirements for new plants when *ID 2001-3* was issued were also examined.

The drop in sulphur emissions from these nongrandfathered plants was about 20 per cent between 2000 and 2004. A smaller reduction in sulphur inlet, about 3 per cent, occurred over the same period. Details on these reductions on an individual plant basis for plants with sulphur recovery are given in Appendix 4.

4 Summary of Overall Performance for Grandfathered and Nongrandfathered Plants, 2000-2004

Examining sulphur inlet and sulphur emissions from both the grandfathered acid gas flaring and sulphur recovery facilities and nongrandfathered acid gas injection and sulphur recovery facilities reveals a 28 per cent drop in emissions. Of the 28 per cent, 16 per cent was due to improved performance and modifications and 12 per cent was due to a decline in sulphur inlet.

Appendix 1.1. Grandfathered Sulphur Recovery (SR) Gas Plants

		Plant Code	Current Approved Sulphur Recovery Efficiency (%)	Guideline Recovery for Approved Sulphur Inlet (%)	Daily Approved S Inlet (t/d)	Baseline Capacity 1999 S Inlet (t/d)	Change in Status (from *ID 2001-3*)
1	Brazeau R. - Keyera[1]	1108	98.4	98.4%	400.0	67.3	Degrandfathered in 2003; became AGI
2	Brazeau R. (Nordegg) - Keyera	1121	93.5	95.9%	49.8	38.2	
3	Burnt Timber - Shell	1131	96.5	98.4%	560.0	412.4	
4	Caroline (North) 1-11 - BP Canada	1374	69.7	69.7%	5.0	5.0	Plant shut down in 2003
5	Caroline (South) 4-20 - BP Canada	1104	85.0	89.7%	9.8	6.8	Plant shut down in 2003
6	Carstairs - Bonavista	1020	90.0	98.2%	72.2*	9.5	
7	Crossfield (Balzac) - Nexen	1050	98.0	98.5%	1,730.1	414.6	
8	Edson - Talisman	1084	98.4	98.4%	350.0	220.9	Degrandfathered in 2003; upgraded SR
9	Gold Creek - CNRL	1129	97.0	98.3%	100.0	64.1	
10	Jumping Pound - Shell	1037	96.2	98.4%	619.0	472.1	
11	Kaybob S. 1 & 2 - BP Canada	1107	98.4	98.5%	1,107.7	540.6	
12	Kaybob S. 3 - Central Midstream	1144	98.1	99.5%	3,629.7	1,009.6	
13	Lone Pine Ck. - ExxonMobil	1139	98.0	98.3%	165.4	129.5	
14	Minnehik B. L. - Penn West	1047	95.6	95.9%	49.2	22.0	
15	Okotoks (Mazeppa) - Mazeppa Processing	1530	98.4	98.4%	586.6	263.4	Degrandfathered in 2002
16	Redwater - Imperial	1028	Fluctuating	95.9%	12.2*	3.1	
17	Rosevear (North) - Suncor	1206					Plant shut down in 2001
18	Rosevear (South) - Suncor	1268	95.6	98.3%	171.0	76.0	Plant consolidation 1206
19	Simonette - Suncor	1113	98.3	98.3%	120.0	92.3	
20	Strachan (Ram River) - Husky	1141	98.1	99.5%	4,660.5*	2,301.8	
21	Strachan - Keyera	1133	98.1	98.4%	971.1	264.9	
22	Sturgeon Lk. - Chariot Energy	1112	95.9	95.9%	49.8	40.6	Degrandfathered in 2005
23	Teepee -Talisman	1296	92.0	95.9%	25.0	17.5	
24	Waterton - Shell	1056	98.7	99.5%	3,148.0	2,099.6	
25	Wildcat Hills - Petro-Canada	1054	97.5	98.3%	287.5	181.3	
26	Wimborne - Devon	1081	95.5	98.3%	235.0	182.1	
27	Windfall (West Whitecourt) - BP Canada	1034	98.3	98.5%	1,356.1	777.6	
28	Zama - Apache[2]	1219	92.0	98.2%	80.3	38.6	Baseline revision 2001

* Annual average sulphur inlet.

[1] KeySpan Brazeau River became an AGI facility in 2003. Injected sulphur volumes in 2004 were 170.7 t/d.

[2] As of October 2004, Zama was delivering acid gas to its Apache Zama acid gas injection (AGI) plant.

Appendix 1.2. Grandfathered Acid Gas Flaring Plants

		Plant Code	Guideline Recovery for Approved Sulphur Inlet (%)	2004 S Emissions (t/d)	Approved S Inlet (t/d)	Baseline Capacity 1999 S Inlet (t/d)	Change in Status (from *ID 2001-3*)
1	Ansell (Galloway) - CNRL	1417	69.7	0.42	1.40	1.3	
2	Bantry - AltaGas	1114	69.7	0.76	2.00	1.0	Degrandfathered in 2002; became SR
3	Bellshill Lake - Viking Holdings[1]	1280	89.7	2.39	5.77	3.8	Degrandfathered in 2005; became AGI
4	Big Bend - CNRL	1293	69.7	0.08	1.46	1.0	
5	Bigoray - Penn West	1138	69.7	0.75	2.96	1.8	
6	Bittern Lake - CNRL	1124	69.7	0.00	2.48	1.0	Plant shut down in 2000
7	Boundary Lake S - Penn West	1202	69.7	0.72	2.20	1.1	
8	Boundary Lake S - Talisman	1024	69.7	0.81	1.90	1.0	
9	Carson Creek - ExxonMobil	1062	69.7	0.27	1.00	1.0	
10	Enchant - Taylor Management	1039	69.7	0.26	1.25	1.0	
11	Forestburg - Signalta	1365	69.7	1.49	4.50	4.0	
12	Greencourt - CNRL	1127	69.7	1.02	2.84	1.3	
13	Harmattan-Elkton - Bonavista	1083	69.7	0.28	1.60	1.0	
14	Judy Creek - Pengrowth	1069	69.7	2.01	3.60	2.7	
15	Kaybob - Trilogy	1058	89.7	1.04	5.15	1.0	
16	Killam (Sedgewick) - AltaGas	1510	69.7	1.27	4.75	2.2	
17	Leduc - Woodbend - Imperial	1023	69.7	0.00	1.01	1.0	
18	Little Bow (Travers) - ConocoPhillips	1150	69.7	0.80	1.60	1.2	
19	Retlaw (Turin) - Taylor Management[2]	1191	69.7	1.12	4.64	1.7	Degrandfathered in 2004; became AGI
20	Spirit River - Bonavista	1560	69.7	0.63	2.60	1.0	
21	Strome - CNRL	1179	69.7	0.24	3.40	1.6	
22	Sylvan Lake - NAL Resources	1070		0.30	0.75	1.0	Degrandfathered in 2002
23	Virginia Hills (Hope Creek) - Apache[3]	1135	95.9	4.60	16.00	5.2	Degrandfathered in 2004; became AGI
24	Vulcan - (Long Coulee) ConocoPhillips[4]	1100	69.7	0.02	4.90	2.7	Degrandfathered in 2002; became AGI
25	West Drumheller - Acclaim	1109	69.7	0.27	2.99	1.1	
26	Whitecourt - Shiningbank	1115	89.7	2.71	7.50	3.5	
27	Wilson Creek - Imperial	1399	69.7	0.14	1.68	1.0	
28	Wilson Creek - Petro-Canada	1096	69.7	0.12	4.70	2.3	Degrandfathered in 2001; became SR

[1] Viking Bellshill Lk started AGI in January 2005.

[2] Taylor Retlaw injected sulphur in 2004 was 0.79 t/d.

[3] Apache Virginia Hills injected sulphur in 2004 was 2.15 t/d.

[4] ConocoPhillips Vulcan injected sulphur in 2004 was 1.96 t/d.

Appendix 1.3. Nongrandfathered Sulphur Recovery Plants

		Plant Code	Current Approved Sulphur Recovery Efficiency (%)	Approved S Inlet (t/d)
1	Basing (Hanlan Robb) - Petro-Canada	1360	98.5	1,270.0
2	Bonnie Glen - Imperial	1045	95.9	35.6
3	Brazeau R. - Petro-Canada	1482	98.4	500.0
4	Brazeau R. (West Pembina) - Atco Midstream	1458	98.4	520.0
5	Campbell-Namao (Carbondale) - Atco Midstream	1638	69.7	1.15*
6	Caroline - Shell	1662	99.5	5,450.0
7	Crossfield E. - Primewest	1079	98.4	863.8
8	Garrington (Olds) - Esprit	1021	98.4	404.9
9	Harmattan - Solex	1060	98.6	82.7
10	Hays - Anadarko	1585	90.0	9.9
11	Homeglen Rimbey - Keyera	1004	98.3	150.0
12	Nevis - Duke Energy	1002	98.4	300.0
13	Progress - Anadarko	1506	96.5	49.5
14	Progress - Suncor	1629	69.7	2.5
15	Quirk Ck. - Imperial	1134	98.3	306.4*
16	Rainbow - Husky[1]	1105	98.3	213.5
17	Rainbow - AltaGas	1658	95.9	23.2
18	Saddle Hills (LaGlace) - EnCana	1892	98.4	483.1
19	Savanna Ck. (Coleman) - Northstar	1051	98.6	800.0
20	Sinclair (Hythe Brainard) - EnCana	1147	98.3	132.2
21	Swalwell - Viking Holdings	1654	70.0	4.6
22	Valhalla - Primewest[2] (new)	1960	70.0	3.5

* Annual average sulphur inlet

[1] Husky Rainbow started as an AGI facility in January 2002. Injected sulphur was 119.4 t/d for 2004

[2] Previously was nongrandfathered acid gas flaring plant.

Appendix 1.4. Nongrandfathered Acid Gas Injection Plants

	Nongrandfathered acid gas injection plants	Plant Code	Sulphur Recovery Equivalent Required (%)	Approved S Inlet (t/d)	2004 S Emissions (t/d)	2004 Sulphur Injected (t/d)
1	Acheson -Acclaim	1628	69.7	4.65	0.00	0.92
2	Bistcho Lk - Paramount	1975	95.9	25.00	0.22	10.79
3	Bigoray - Enerpro Midstream	1357	98.2	64.00	0.57	26.62
4	Boundary Lk S (Clear Hills) - CNRL	1880	95.9	15.35	0.03	9.74
5	Dizzy (Steen River) Penn West	1738	95.9	34.40	0.03	3.73
6	Dunvegan - Devon	1169	89.7	9.90	0.00	0.54
7	Eaglesham - (West Culp) Devon	1775	95.9	17.20	0.03	1.81
8	Galahad - Husky	1690	89.7	7.54	0.01	2.78
9	Golden Spike - Atco Midstream	1547	95.9	26.46	0.00	2.92
10	Gordondale - Duke	1668	98.2	54.30	0.03	21.59
11	Kelsey (Rosalind) - Thunder	1244	69.7	2.50	0.01	1.64
12	Leduc-Woodbend (Calmar) - Midcoast Canada	1676	95.9	15.54	0.00	2.64
13	Marlowe (Dizzy) - Bearspaw	1765	95.9	19.70	0.00	0.00
14	Mulligan (Fourth Creek) - Duke	1895	89.7	10.00	0.03	7.45
15	Normandville - Devon	1990	69.7	1.90	0.00	0.07
16	O'Chiese - Burlington	1970	95.9	14.53	0.01	0.38
17	Paddle River - Keyera	1089	69.7	1.50	0.00	0.76
18	Pembina - Enerpro Midstream	1402	95.9	29.70*	0.14	13.27
19	Pembina - Imperial	1625	89.7	7.23	0.03	2.28
20	Pouce Coupe - Duke	1746	95.9	26.20	0.07	8.58
21	Provost (Hansman Lk) - Husky	1698	89.7	6.90	0.04	4.84
22	Provost (Thompson Lk) - Husky	1695	95.9	12.00	0.09	5.07
23	Puskwaskau - Devon	1964	89.7	5.15	0.01	0.25
24	Rainbow - ExxonMobil	1155	95.9	20.10*	0.31	9.17
25	Rainbow - Husky	1105	98.3	213.49	0.38	119.36
26	Rycroft - Devon	1793	95.9	21.00	0.03	5.15
27	Watelet (Glen Park) - Atco Midstream	1672	69.7	3.30	0.01	0.96
28	Wayne-Rosedale - EnCana	1888	89.7	5.90*	0.05	1.88
29	Wembley - ConocoPhillips	1520	98.3	124.00	0.14	44.23
30	Zama - Apache	1878&1978	98.3	247.00	0.13	42.69
	Grandfathered plants (sulphur recovery or acid gas flaring) that are now acid gas injection					
31	Bellshill Lake - Viking Holdings	1280	89.7	5.77	AGI started in Jan 2005	
32	Brazeau R. - Keyera	1108	98.4	400.00	0.30	170.68
33	Retlaw (Turin) - Taylor Management	1191	89.7	4.64	1.12	0.79
34	Virginia Hills (Hope Creek) - Apache	1135	95.9	16.00	4.60	2.15
35	Vulcan - (Long Coulee) ConocoPhillips	1100	89.7	4.90	0.02	1.96

Appendix 2. Plants That Have Been Degrandfathered

				Approved S Inlet max daily	
Plants that have made modifications		**Plant Code**	**Plant Name**	**(t/d)**	**Modification Process**
1	Plant Mods	1108	Brazeau R. - Keyera	400.00	(AGI)
2	Plant Mods	1021	Garrington (Olds) - Esprit	404.90	(SuperClaus)
3	Plant Mods	1004	Homeglen Rimbey - Keyera	150.00	(SuperClaus)
4	Plant Mods	1114	Bantry - AltaGas	2.00	(Xergy)
5	Plant Mods	1100	Vulcan (Long Coulee) - ConocoPhilips	4.90	(AGI)
6	Plant Mods	1096	Wilson Creek - Petro-Canada	4.70	(Claus)
7	Plant Mods	1105	Rainbow - Husky	213.50	(AGI)
8	Plant Mods	1084	Edson - Talisman	350.00	(SuperClaus)
9	Plant Mods	1191	Retlaw (Turin) - Taylor Management	4.64	(AGI)
10	Plant Mods	1135	Virginia Hills - Apache	16.00	(AGI)
11	Plant Mods	1280	Bellshill - Viking Holdings	5.77	(AGI)
Plants that have been relicensed to higher S recovery efficiency or lower sulphur inlets					
12	Relicensed	1530	Okotoks (Mazeppa) - Mazeppa Processing	586.60	
13	Relicensed	1079	Crossfield E. - Primewest	863.80	
14	Relicensed	1070	Sylvan Lake - NAL Resources	0.75	
15	Relicensed	1112	Sturgeon Lake - Chariot	49.81	
Other - Sulphur recovery not required, given the low approved sulphur inlet					
1	Plant Mods	1739	Bantry - EnCana	0.92	(Shell Paques/New Paradigm)

Appendix 3. Sulphur Credits Earned

		Grandfathered sulphur recovery gas plants	Credits				Cumulative Credits				Status
			Jan-Mar 2004	Apr-Jun 2004	Jul-Sep 2004	Oct-Dec 2004	Jan-Mar 2004	Apr-Jun 2004	Jul-Sep 2004	Oct-Dec 2004	
	Plant Code										
1	1108	Brazeau R. - Keyera	-	-	-	-	-	-	-	-	Degrandfathered
2	1121	Brazeau R. (Nordegg) - Keyera	50.1	19.4	54.1	14.8	435.1	454.6	508.7	523.5	
3	1131	Burnt Timber - Shell	29.1	11.6	12.9	31.4	943.6	955.2	968.1	999.5	
4	1374	Caroline (North) 1-11 - BP Canada	-	-	-	-	-	-	-	-	Plant shut down
5	1104	Caroline (South) 4-20 - BP Canada	-	-	-	-	-	-	-	-	Plant shut down
6	1020	Carstairs - Bonavista	10.6	16.8	13.8	15.2	151.3	168.1	181.8	197.0	
7	1050	Crossfield (Balzac) - Nexen	103.6	98.5	31.7	34.3	1,305.0	1,403.5	1,435.2	1,469.5	
8	1084	Edson - Talisman	-	-	-	-	122.2	122.2	122.2	122.2	Degrandfathered
9	1129	Gold Creek - CNRL	-	-	-	47.0	-	-	0.0	47.0	
10	1037	Jumping Pound - Shell	286.8	230.4	197.4	122.1	1,887.0	2,117.4	2,314.8	2,436.9	
11	1107	Kaybob S. 1 & 2 - BP Canada	207.9	62.8	84.1	186.8	1,868.0	1,930.8	2,014.9	2,201.7	
12	1144	Kaybob S. 3 - Central Midstream	85.6	92.8	181.5	304.6	1,223.6	1,316.4	1,497.9	1,802.5	
13	1139	Lone Pine Ck. - ExxonMobil	0.0	22.0	11.3	12.5	95.1	117.0	128.3	140.8	
14	1047	Minnehik B. L. - Penn West	3.0	-1.2	8.3	8.2	41.9	40.7	49.1	57.2	
15	1530	Okotoks - Mazeppa Processing	-	-	-	-	-	-	-	-	Degrandfathered
16	1028	Redwater - Imperial	20.9	43.9	45.8	40.7	20.9	64.7	110.6	151.2	Variable inlet rate
17	1206	Rosevear (North) - Suncor[1]	-	-	-	-	-	-	-	-	Plant shut down
18	1268	Rosevear (South) - Suncor[1]	106.6	99.5	50.2	82.1	1,040.8	1,140.3	1,190.5	1,272.6	
19	1113	Simonette - Suncor	55.0	59.9	50.1	50.3	532.0	591.9	642.0	692.3	
20	1141	Strachan (Ram River) - Husky	1,809.4	1,800.0	1,743.7	1,907.2	14,894.0	16,694.0	18,437.6	20,344.8	
21	1133	Strachan - Keyera	93.6	73.2	79.9	62.5	795.2	868.4	948.2	1,010.7	
22	1112	Sturgeon Lk. - Chariot Energy	29.9	9.7	46.3	79.0	455.6	465.3	511.6	590.6	Degrandfathered
23	1296	Teepee - Talisman	51.9	49.0	27.2	19.4	355.3	404.3	431.5	450.9	
24	1056	Waterton - Shell	715.6	409.2	397.4	554.8	4,739.5	5,148.7	5,546.1	6,100.9	
25	1054	Wildcat Hills - Petro-Canada	95.6	98.6	82.7	99.3	1,086.8	1,185.4	1,268.1	1,367.3	
26	1081	Wimborne - Devon	69.5	77.7	72.2	49.2	1,031.2	1,109.0	1,181.2	1,230.4	
27	1034	Windfall (West Whitecourt) - BP Canada	229.2	195.2	135.0	204.2	2,921.4	3,116.6	3,251.6	3,455.8	
28	1219	Zama - Apache[2]	35.8	105.4	97.2	-	778.0	883.4	980.6	980.6	Delivers acid gas to its Apache Zama AGI plant as of October 2004
		Totals	4,089.77	3,574.39	3,422.63	3,925.42	36,723.4	40,297.8	43,720.4	47,645.9	

[1] Plant consolidation

[2] Apache Zama - shipping acid gas to adjacent AGI gas plant

Appendix 4.1. Gas Plants with Sulphur Recovery, Year 2004 Minus Year 2000

	Plant Code	Field-Licensee	Change in production and emissions year 2004 minus year 2000 2004-2000 S Production (t/y)	2004-2000 S Emission (t S/y)
Grandfathered plants (in 2001)				
1	1034	Windfall (West Whitecourt) - BP Canada	(172,199.2)	(3,310.5)
2	1141	Strachan (Ram River) - Husky	(143,729.1)	(2,929.2)
3	1108	Brazeau R. - Keyera	(35,158.5)	(2,044.3)
4	1037	Jumping Pound - Shell	(44,522.4)	(1,875.1)
5	1107	Kaybob S. 1 & 2 - BP Canada	(125,736.2)	(1,291.5)
6	1056	Waterton - Shell	(135,907.8)	(1,120.1)
7	1113	Simonette - Suncor	(17,465.6)	(513.1)
8	1206	Rosevear (North) - Suncor	(12,290.7)	(499.6)
9	1081	Wimborne - Devon	(7,218.6)	(391.5)
10	1133	Strachan - Keyera	(40,140.8)	(372.9)
11	1104	Caroline (South) 4-20 - BP Canada	(2,186.0)	(349.5)
12	1112	Sturgeon Lk. - Chariot Energy	(7,976.2)	(237.7)
13	1530	Okotoks (Mazeppa) - Mazeppa Processing	(10,545.2)	(204.6)
14	1084	Edson - Talisman	(230.7)	(198.2)
15	1121	Brazeau R. (Nordegg) - Keyera	(2,806.6)	(177.5)
16	1219	Zama - Apache	(6,585.7)	(158.6)
17	1047	Minnehik B. L. - Penn West	(3,690.8)	(148.3)
18	1129	Gold Creek - CNRL	(7,174.9)	(140.3)
19	1020	Carstairs - Bonavista	(984.3)	(121.5)
20	1144	Kaybob S. 3 - Central Midstream	119.9	(99.6)
21	1374	Caroline (North) 1-11 - BP Canada	(903.1)	(86.8)
22	1050	Crossfield (Balzac) - Nexen	(12,100.9)	(59.6)
23	1296	Teepee - Talisman	908.4	(22.8)
24	1028	Redwater - Imperial	(283.1)	18.3
25	1054	Wildcat Hills - Petro-Canada	(1,760.3)	52.2
26	1268	Rosevear (South) - Suncor	661.6	70.4
27	1139	Lone Pine Ck. - ExxonMobil	(78.1)	110.9
28	1131	Burnt Timber - Shell	(1,952.1)	409.1
	Totals		**(801,937.0)**	**(15,692.0)**
Grandfathered plants that were previously acid gas flaring and are now sulphur recovery				
1	1096	Wilson Creek - Petro-Canada	534.2	(991.1)
2	1114	Bantry - AltaGas	135.5	(34.2)
			669.7	**(1,025.3)**
New suphur recovery plant (new S recovery gas plants or plants previously licensed for less than 1 t S inlet /d)				
1	1960	Valhalla - Primewest	138.3	60.7
			138.3	**60.7**
Nongrandfathered plants (plants meeting the requirements for new plants)				
1	1079	Crossfield E. - Primewest	(51,914.5)	(1,425.8)
2	1105	Rainbow - Husky	(22,351.5)	(985.8)
3	1021	Garrington (Olds) - Esprit	(739.0)	(894.5)
4	1004	Homeglen Rimbey - Keyera	(6,123.9)	(861.2)
5	1360	Basing (Hanlan Robb) - Petro-Canada	(18,292.4)	(427.0)
6	1458	Brazeau R. (West Pembina) - Atco Midstream	7,694.3	(394.4)
7	1662	Caroline - Shell	(67,351.5)	(290.5)
8	1002	Nevis - Duke Energy	(4,776.8)	(100.8)
9	1060	Harmattan - Solex	(3,932.1)	(50.0)
10	1585	Hays - Anadarko	(45.7)	(26.2)
11	1045	Bonnie Glen - Imperial	694.2	(6.0)
12	1638	Campbell-Namao (Carbondale) - Atco Midstream	(192.1)	(0.2)
13	1629	Progress - Suncor	229.3	-
14	1506	Progress - Anadarko	2,116.3	13.6
15	1654	Swalwell - Viking Holdings	(136.5)	21.0
16	1658	Rainbow - AltaGas	2,325.1	22.2
17	1051	Savanna Ck. (Coleman) - Northstar	4,713.1	65.7
18	1147	Sinclair (Hythe Brainard) - EnCana	7,961.1	98.2
19	1892	Saddle Hills - EnCana	(42.0)	258.6
20	1134	Quirk Ck. - Imperial	8,687.9	353.1
21	1482	Brazeau R. - Petro-Canada	32,407.0	471.3
	Totals		**(119,069.6)**	**(4,168.7)**
	Grand totals		**(920,198.6)**	**(20,825.3)**

Appendix 4.2. Gas Plants with Sulphur Recovery, Year 2000

	Plant Code	Field-Licensee	Total Inlet (t/y)	Total Annual Emissions (t S/y)	Actual Sulphur Recovery Effic. (%)	Current Required Sulphur Recovery Effic. (%)	Total Annual Production (t/y)
Grandfathered Plants (in 2001)							
1	1034	Windfall (West Whitecourt) - BP Canada	286,311.3	4,616.6	98.4%	98.3	292,237.0
2	1141	Strachan (Ram River) - Husky	791,052.9	7,877.7	99.0%	98.1	781,009.3
3	1108	Brazeau R. - Keyera	36,697.0	2,152.6	94.2%	92.1	35,158.5
4	1037	Jumping Pound - Shell	161,744.1	5,509.7	96.6%	96.2	158,522.1
5	1107	Kaybob S. 1 & 2 - BP Canada	234,341.8	2,756.9	98.9%	98.4	250,134.3
6	1056	Waterton - Shell	671,377.4	6,233.1	99.1%	98.7	679,224.2
7	1113	Simonette - Suncor	32,358.2	793.8	97.5%	96.5	31,239.2
8	1206	Rosevear (North) - Suncor	10,771.6	499.6	96.1%	94.6	12,290.7
9	1081	Wimborne - Devon	57,618.0	1,833.9	96.7%	95.5	54,008.0
10	1133	Strachan - Keyera	97,769.5	1,169.6	98.8%	98.1	97,129.6
11	1104	Caroline (South) 4-20 - BP Canada	2,483.7	349.5	86.2%	85.0	2,186.0
12	1112	Sturgeon Lk. - Chariot Energy	18,698.9	729.2	96.2%	94.0	18,456.1
13	1530	Okotoks (Mazeppa) - Mazeppa Processing	95,120.2	1,260.7	98.7%	98.3	95,760.9
14	1084	Edson - Talisman	73,009.3	1,421.2	98.1%	97.9	73,337.4
15	1121	Brazeau R. (Nordegg) - Keyera	12,991.3	727.9	94.6%	93.5	12,842.1
16	1219	Zama - Apache	15,117.5	583.9	96.1%	92.0	14,405.1
17	1047	Minnehik B. L. - Penn West	7,018.8	270.4	96.1%	95.6	6,748.4
18	1129	Gold Creek - CNRL	20,071.4	514.9	97.6%	97.0	20,883.0
19	1020	Carstairs - Bonavista	3,815.5	324.6	91.2%	90.0	3,370.0
20	1144	Kaybob S. 3 - Central Midstream	360,565.8	6,646.1	98.2%	98.1	369,708.4
21	1374	Caroline (North) 1-11 - BP Canada	1,039.2	86.8	91.2%	89.7	903.1
22	1050	Crossfield (Balzac) - Nexen	144,323.2	2,408.8	98.3%	98.0	141,245.3
23	1296	Teepee - Talisman	5,424.7	372.2	93.2%	92.0	5,070.9
24	1028	Redwater - Imperial	1,184.9	88.3	92.7%	Fluctuating	1,118.3
25	1054	Wildcat Hills - Petro-Canada	71,413.7	1,220.0	98.2%	97.5	66,931.2
26	1268	Rosevear (South) - Suncor	16,104.4	457.5	97.6%	95.6	18,426.7
27	1139	Lone Pine Ck. - ExxonMobil	38,390.2	599.7	98.4%	98.0	37,232.3
28	1131	Burnt Timber - Shell	156,959.7	4,844.0	96.9%	96.5	152,115.5
	Totals		**3,423,774.2**	**56,349.2**	**98.4%**		**3,431,693.7**
Grandfathered plants that were previously acid gas flaring and are now sulphur recovery							
1	1096	Wilson Creek - Petro-Canada	908.0	1,036.4	0.0%	-	-
2	1114	Bantry - AltaGas	310.6	310.7	0.0%	-	-
			1,218.5	**1,347.1**	**0.0%**		-
Plants that were previously acid gas flaring that had emissions of less than 1 t/d and are now sulphur recovery							
1	1960	Valhalla - Primewest	-	-	**0.0%**	-	-
			-	-	**0.0%**		-
Nongrandfathered Plants (Plants Meeting the Requirements for New Plants)							
1	1079	Crossfield E. - Primewest	170,668.1	3,028.6	98.2%	98.0	169,921.2
2	1105	Rainbow - Husky	25,910.0	1,123.5	95.2%	95.0	22,351.5
3	1021	Garrington (Olds) - Esprit	103,220.0	2,152.2	97.9%	97.1	101,783.0
4	1004	Homeglen Rimbey - Keyera	19,957.4	1,003.0	94.8%	92.0	18,208.7
5	1360	Basing (Hanlan Robb) - Petro-Canada	299,824.2	3,434.8	98.8%	98.5	288,911.9
6	1458	Brazeau R. (West Pembina) - Atco Midstream	107,983.1	1,624.1	98.6%	98.4	112,615.2
7	1662	Caroline - Shell	1,833,270.9	2,458.5	99.9%	99.8	1,844,827.3
8	1002	Nevis - Duke Energy	37,590.7	467.5	98.8%	98.4	37,091.8
9	1060	Harmattan - Solex	11,515.1	164.6	98.6%	98.6	11,875.6
10	1585	Hays - Anadarko	2,390.2	129.0	94.5%	90.0	2,217.5
11	1045	Bonnie Glen - Imperial	3,281.6	125.8	96.1%	95.9	3,062.0
12	1638	Campbell-Namao (Carbondale) - Atco Midstream	364.59	0.2	100.0%	69.7	403.7
13	1629	Progress - Suncor	389.10	-	100.0%	69.7	336.7
14	1506	Progress - Anadarko	9,215.7	237.8	97.4%	96.5	9,060.8
15	1654	Swalwell - Viking Holdings	517.6	138.9	79.3%	70.0	533.4
16	1658	Rainbow - AltaGas	1,882.0	127.9	92.6%	70.0	1,597.4
17	1051	Savanna Ck. (Coleman) - Northstar	137,197.0	1,369.9	99.0%	98.6	136,352.7
18	1147	Sinclair (Hythe Brainard) - EnCana	28,431.8	296.2	99.0%	98.3	28,291.8
19	1892	Saddle Hills - EnCana	125,906.9	1,292.3	99.0%	98.4	126,382.7
20	1134	Quirk Ck. - Imperial	88,771.0	1,002.1	98.9%	98.3	90,372.6
21	1482	Brazeau R. - Petro-Canada	97,601.0	917.1	99.1%	98.4	96,505.4
	Totals		**3,103,888.0**	**21,094.0**	**99.3%**		**3,102,702.9**
		Grand totals	**6,528,880.7**	**78,790.3**	**98.8%**		**6,534,396.6**

Appendix 4.3. Gas Plants with Sulphur Recovery, Year 2004

	Plant Code	Field-Licensee	Total Inlet (t/y)	Total Annual Emissions (t S/y)	Annual Sulphur Recovery (%)	Current Required Sulphur Recovery Effic. (%)	Total Actual Production (t/y)
Grandfathered plants (in 2001)							
1	1034	Windfall (West Whitecourt) - BP Canada	121,450.4	1,306.1	98.9%	98.3	120,037.8
2	1141	Strachan (Ram River) - Husky	640,990.8	4,948.5	99.2%	98.1	637,280.2
3	1108	Brazeau R. - Keyera	62,499.2	108.3	99.8%	98.4	Injected (62470.5)
4	1037	Jumping Pound - Shell	116,231.7	3,634.6	96.9%	96.2	113,999.7
5	1107	Kaybob S. 1 & 2 - BP Canada	127,045.3	1,465.4	98.8%	98.4	124,398.1
6	1056	Waterton - Shell	550,669.5	5,113.0	99.1%	98.7	543,316.4
7	1113	Simonette - Suncor	14,313.3	280.7	98.0%	96.5	13,773.6
8	1206	Rosevear (North) - Suncor	-	-	0.0%	0.0	-
9	1081	Wimborne - Devon	36,943.5	1,442.4	96.2%	95.5	36,789.4
10	1133	Strachan - Keyera	59,276.5	796.7	98.6%	98.1	56,988.8
11	1104	Caroline (South) 4-20 - BP Canada	-	-	0.0%	85.0	-
12	1112	Sturgeon Lk. - Chariot Energy	10,893.5	491.5	95.5%	95.9	10,479.9
13	1530	Okotoks (Mazeppa) - Mazeppa Processing	89,075.3	1,056.1	98.8%	98.4	85,215.7
14	1084	Edson - Talisman	68,985.6	1,223.0	98.4%	98.4	73,106.7
15	1121	Brazeau R. (Nordegg) - Keyera	10,549.6	550.4	94.8%	93.5	10,035.5
16	1219	Zama - Apache	10,846.9	425.3	94.8%	92.0	7,819.4
17	1047	Minnehik B. L. - Penn West	3,241.5	122.1	96.2%	95.6	3,057.6
18	1129	Gold Creek - CNRL	14,204.6	374.6	97.3%	97.0	13,708.1
19	1020	Carstairs - Bonavista	2,611.8	203.1	92.2%	90.0	2,385.7
20	1144	Kaybob S. 3 - Central Midstream	370,651.1	6,546.5	98.3%	98.1	369,828.3
21	1374	Caroline (North) 1-11 - BP Canada	-	-	0.0%	69.7	-
22	1050	Crossfield (Balzac) - Nexen	133,410.6	2,349.2	98.2%	98.0	129,144.4
23	1296	Teepee - Talisman	6,346.9	349.4	94.5%	92.0	5,979.3
24	1028	Redwater - Imperial	932.1	106.6	88.7%	Fluctuating	835.2
25	1054	Wildcat Hills - Petro-Canada	68,513.9	1,272.2	98.1%	97.5	65,170.9
26	1268	Rosevear (South) - Suncor	19,645.7	527.9	97.3%	95.6	19,088.3
27	1139	Lone Pine Ck. - ExxonMobil	37,681.5	710.6	98.1%	98.0	37,154.2
28	1131	Burnt Timber - Shell	147,354.7	5,253.1	96.6%	96.5	150,163.4
	Totals		**2,724,365.37**	**40,657.25**	**98.5%**		**2,629,756.64**
Grandfathered plants that were previously acid gas flaring and are now sulphur recovery							
1	1096	Wilson Creek - Petro-Canada	519.9	45.3	92.2%	85.0	534.2
2	1114	Bantry - AltaGas	491.1	276.5	32.9%	69.7	135.5
			1,011.0	**321.8**	**67.5%**		**669.7**
Plants that were previously acid gas flaring that had emissions of less than 1 t/d and are now sulphur recovery							
1	1960	Valhalla - Primewest	138.4	60.7	69.5%	70.0	138.3
			138.4	**60.7**	**69.5%**		**138.3**
Nongrandfathered plants (plants meeting the requirements for new plants in 2001)							
1	1079	Crossfield E. - Primewest	111,228.4	1,602.80	98.5%	98.4	108,006.70
2	1105	Rainbow - Husky	34,352.6	137.69	99.7%	98.3	Injected (43686.59)
3	1021	Garrington (Olds) - Esprit	99,964.0	1,257.70	98.8%	98.4	101,044.00
4	1004	Homeglen Rimbey - Keyera	11,620.0	141.80	98.8%	98.3	12,084.80
5	1360	Basing (Hanlan Robb) - Petro-Canada	274,964.2	3,007.81	98.9%	98.5	270,619.52
6	1458	Brazeau R. (West Pembina) - Atco Midstream	109,828.1	1,229.70	99.0%	98.4	120,309.50
7	1662	Caroline - Shell	1,756,064.6	2,168.00	99.9%	99.5	1,777,475.80
8	1002	Nevis - Duke Energy	32,768.1	366.70	98.9%	98.4	32,315.00
9	1060	Harmattan - Solex	7,852.9	104.56	98.7%	98.6	7,943.49
10	1585	Hays - Anadarko	2,355.1	102.80	95.5%	90.0	2,171.84
11	1045	Bonnie Glen - Imperial	4,100.4	119.83	96.9%	95.9	3,756.20
12	1638	Campbell-Namao (Carbondale) - Atco Midstream	213.88	-	100.0%	69.7	211.65
13	1629	Progress - Suncor	559.90	-	100.0%	69.7	566.00
14	1506	Progress - Anadarko	11,379.1	251.35	97.8%	96.5	11,177.11
15	1654	Swalwell - Viking Holdings	548.5	159.94	71.3%	70.0	396.86
16	1658	Rainbow - AltaGas	4,081.4	150.11	96.3%	95.9	3,922.50
17	1051	Savanna Ck. (Coleman) - Northstar	134,107.9	1,435.60	99.0%	98.6	141,065.80
18	1147	Sinclair (Hythe Brainard) - EnCana	40,411.3	394.38	98.9%	98.3	36,252.88
19	1892	Saddle Hills - EnCana	135,566.1	1,550.90	98.8%	98.4	126,340.70
20	1134	Quirk Ck. - Imperial	98,437.4	1,355.20	98.7%	98.3	99,060.50
21	1482	Brazeau R. - Petro-Canada	127,213.3	1,388.38	98.9%	98.4	128,912.44
	Totals		**2,997,617.1**	**16,925.2**	**99.4%**		**2,983,633.3**
		Grand totals	**5,723,131.9**	**57,965.0**	**99.0%**		**5,614,197.9**